6. Site Characterization

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Introduction

Site characterization provides the information needed to identify site hazards and to select worker protection methods. The more accurate, detailed, and comprehensive the information available about a site, the more the protective measures can be tailored to the actual hazards that workers may encounter.

The person with primary responsibility for site characterization and assessment is the Project Team Leader. In addition, outside experts, such as chemists, health physicists, industrial hygienists, and toxicologists, may be needed to accurately and fully interpret all the available information on site conditions.

Site characterization generally proceeds in three phases:

- Prior to site entry, conduct offsite characterization: gather information away from the site and conduct reconnaissance from the site perimeter.
- Next, conduct onsite surveys. During this phase, restrict site entry to reconnaissance personnel.
- Once the site has been determined safe for commencement of other activities, perform ongoing monitoring to provide a continuous source of information about site conditions. It is important to recognize that site characterization is a continuous process. At each phase of site characterization, information should be obtained and evaluated to define the hazards that the site may pose. This assessment can then be used to develop a safety and health plan for the next phase of work. In addition to the formal information gathering that takes place during the phases of site characterization described here, all site personnel should be constantly alert for new information about site conditions.

The sections below detail the three phases of site characterization and provide a general guide which should be adapted to meet the specific situation. Within each phase of information

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gathering, the most appropriate sequence of steps should be determined, particularly if there are time or budget considerations that limit the scope of the work. Wherever possible, all information sources should be pursued.

Offsite Characterization

As much information as possible should be obtained *before* site entry so that the hazards can be evaluated and preliminary controls instituted to protect initial entry personnel. Initial information-gathering missions should focus on identifying all potential or suspected conditions that may pose inhalation hazards that are immediately dangerous to life or health (IDLH)[1] or other conditions that may cause death or serious harm (see Table 6-1).

Offsite information can be obtained by two methods: interview/records research and perimeter reconnaissance.

Table 6-1. Visible Indicators of Potential IDLH and Other Dangerous Conditions

- Large containers or tanks that must be entered.
- Enclosed spaces such as buildings or trenches that must be entered.
- Potentially explosive or flammable situations (indicated by bulging drums, effervescence, gas generation, or instrument readings).
- Extremely hazardous materials (such as cyanide, phosgene, or radiation sources).
- Visible vapor clouds.
- Areas where biological indicators (such as dead animals or vegetation) are located.

Interview/Records Research

As much data as possible should be collected before any personnel go on site. Where possible, the following information should be obtained:

- Exact location of the site
- Detailed description of the activity that occurred at the site.
- Duration of the activity.
- Meteorologic data, e.g., current weather and forecast, prevailing wind direction, precipitation levels, temperature profiles.
- Terrain, e.g., historical and current site maps, site photographs, aerial photographs, U.S. Geological Survey topographic quadrangle maps, land use maps, and land cover maps.
- Geologic and hydrologic data.
- Habitation-population centers, population at risk.
- Accessibility by air and roads.
- Pathways of dispersion.
- Present status of response and who has responded.
- Hazardous substances involved and their chemical and physical properties. Information sources Include:
  - Company records, receipts, logbooks, or ledgers.

[1] IDLH conditions refer to inhalation hazards (see section on *IDLH Concentrations* later in this chapter).

    - Records from state and federal pollution control regulatory and enforcement agencies, state Attorney General's office, state occupational safety and health agencies, state Fire Marshal's office. Waste storage inventories and manifests or shipping papers.
    - Interviews with personnel and their families (all interview information should be verified). Generator and transporter records.
    - Water department and sewage district records. Interviews with nearby residents (note possible site-related medical problems and verify all information from interviews).
    - Local fire and police department records. Court records.
    - Utility company records.
    - Media reports (verify all information from the media).
- Previous surveying (including soil, ground-penetrating radar, and magnetometer surveys), sampling, and monitoring data.

Perimeter Reconnaissance

At a site in which the hazards are largely unknown or there is no need to go on site immediately, visual observations should be made, atmospheric concentrations of airborne pollutants at the site perimeter should be monitored (see Chapter 7, *Air Monitoring*), and samples should be collected near the site. While these data are not definitive indicators of onsite conditions, they can assist in the preliminary evaluation. Perimeter reconnaissance of a site should involve the following actions:

- Develop a preliminary site map, with the locations of buildings, containers, impoundments, pits, ponds, and tanks.
- Review historical and current aerial photographs. Note:
- Disappearance of natural depressions, quarries, or pits.
- Variation in reforestation of disturbed areas.
- Mounding or uplift in disturbed areas or paved surfaces, or modifications in grade.
- Changes in vegetation around buildings.
- Changes in traffic patterns at the site.
- Note any labels, markings, or placards on containers or vehicles.
- Note the amount of deterioration or damage of containers or vehicles.
- Note any biologic indicators, such as dead animals or plants.
- Note any unusual conditions, such as clouds, discolored liquids, oil slicks, vapors, or other suspicious substances.
- Monitor the ambient air at the site perimeter (see Chapter 7, *Air Monitoring*) for:
    - Toxic substances.
    - Combustible and flammable gases or vapors.
    - Oxygen deficiency.
    - Ionizing radiation.
    - Specific materials, if known.
- Note any unusual odors.
- Collect and analyze offsite samples (see reference III for methods) including:
    - Soil.
    - Drinking water.
    - Ground water.
    - Site run-off.
    - Surface water.

Protection of Entry Personnel

The information from interview/records research and perimeter reconnaissance is used as the basis for selecting the protective equipment for the initial site survey. In addition, the proposed work to be accomplished must be considered. For example, if the purpose of the survey is to inspect onsite conditions, count containers, measure the ambient air for "hot spots" (i.e., areas with high concentrations of toxic chemicals), and generally become familiar with the site, the level of protection may be less stringent than if containers are to be opened and samples taken. (Chapter 8, *Personal Protective Equipment*, provides more detail on the selection of protective items.)

The ensemble of clothing and equipment referred to as Level B protection is generally the minimum level recommended for an initial entry until the site hazards have been further identified and the most appropriate protective clothing and equipment chosen. Level B equipment is described in Table 8-7, Chapter 8.

Onsite Survey

The purpose of an onsite survey is to verify and supplement information from the offsite characterization. Prior to going on site, the offsite characterization should be used to develop a Site Safety Plan for site entry that addresses the work to be accomplished and prescribes the procedures to protect the health and safety of the entry team. Priorities should be established for hazard assessment and site activities after careful evaluation of probable conditions. Because team members may be entering a largely unknown environment, caution and conservative actions are appropriate. The composition of the entry team depends on the site characteristics but should always consist of at least four persons: two workers who will enter the site and two outside support persons, suited in personal protective equipment and prepared to enter the site in cage of emergency. Upon entering the site, entry personnel should:

- Monitor the air for IDLH and other conditions that may cause death or serious harm (combustible or explosive atmospheres, oxygen deficiency, toxic substances). Chapter 7 provides detailed information on air monitoring.
- Monitor for ionizing radiation. Survey for gamma and beta radiation with a Geiger-Mueller detection tube or a gamma scintillation tube; if alpha radiation is expected, use a proportional counter.
- Visually observe for signs of actual or potential IDLH or other dangerous conditions (see Table 6-1).

Any indication of IDLH hazards or other dangerous conditions should be regarded as a sign to proceed with care and deliberation. Extreme caution should be exercised in continuing the site survey when such hazards are indicated. Table 6-2 provides some basic guidelines for decision-making. If IDLH or other dangerous conditions are not present, or if proper precautions can be taken, continue the survey:

- Conduct further air monitoring as necessary (see Chapter 7).
- Note the types of containers, impoundments, or other storage systems:
  - Paper or wood packages.
  - Metal or plastic barrels or drums.
  - Underground tanks.
  - Aboveground tanks.

- Compressed gas cylinders.
- Pits, ponds, or lagoons.
- Other.

- Note the condition of waste containers and storage systems:
  - Sound (undamaged).
  - Visibly rusted or corroded.
  - Leaking.
  - Bulging.
  - Types and quantities of material in containers.
  - Labels on containers indicating corrosive explosive, flammable, radioactive or toxic materials.

- Note the physical condition of the materials:
  - Gas, liquid, or solid.
  - Color and turbidity.
  - Behavior, e.g., corroding, foaming or vaporizing.
  - Conditions conducive to splash or contact.

- Identify natural wind barriers:
  - Buildings.
  - Hills.
  - Tanks.

- Determine the potential pathways of dispersion:
  - Air.
  - Biologic routes, such as animals and food chains.
  - Ground water.
  - Land surface.
  - Surface water.

- If necessary, use one or more of the following remote sensing or subsurface investigative methods to locate buried wastes or contaminant plumes:
  - Electromagnetic resistivity.
  - Seismic refraction.
  - Magnetometry.
  - Metal detection.
  - Ground-penetrating radar.

- Note any indicators of potential exposure to hazardous substances:
  - Dead fish, animals or vegetation.
  - Dust or spray in the air.
  - Fissures or cracks in solid surfaces that expose deep waste layers.
  - Pools of liquid.
  - Foams or oils on liquid surfaces.
  - Gas generation or effervescence.
  - Deteriorating containers.
  - Cleared land areas or possible landfilled areas.

- Note any safety hazards. Consider:

- Conditions of site structures.
- Obstacles to entry and exit.
- Terrain homogeneity.
- Terrain stability.
- Stability of stacked material.

- Identify any reactive, incompatible, flammable, or highly corrosive wastes.
- Note land features.
- Note the presence of any potential naturally occurring skin irritants or dermatitis-inducing agents, for example:
  - Poison ivy.
  - Poison oak.
  - Poison sumac.
- Note any tags, labels, markings, or other identifying indicators.
- Collect samples [1]:
  - Air (see Chapter 7, *Air Monitoring*).
  - Drainage ditches.
  - Soil (surface and subsurface).
  - Standing pools of liquids.
  - Storage containers.
  - Streams and ponds.
  - Ground water (upgradient, beneath site, downgradient).
- Sample for or otherwise identify:
  - Biologic or pathologic hazards.
  - Radiologic hazards.

Information Documentation

Proper documentation and document control are important for ensuring accurate communication; ensuring the quality of the data collected; providing the rationale for safety decisions; and substantiating possible legal actions. Documentation can be accomplished by recording information pertinent to field activities, sample analysis, and site conditions in one of several ways, including:

- Logbooks.
- Field data records.
- Graphs.
- Photographs.
- Sample labels.
- Chain-of-custody forms.
- Analytical records.

Table 6-2. Guidelines for Some Atmospheric Hazards[a]

HAZARD[b]	MONITORING EQUIPMENT[c]	MEASURED LEVEL	ACTION
Explosive atmosphere	Combustible gas indicator	<10% LEL[d] 10%-25% LEL >25% LEL	Continue investigation. Continue onsite monitoring with extreme caution as higher levels are encountered. Explosion hazard. Withdraw from area immediately.
Oxygen	Oxygen concentration meter	<19.5% 19.5%-25% >25%	Monitor wearing self-contained breathing apparatus. NOTE: Combustible gas readings are not valid in atmospheres with <19.5% oxygen. Continue investigation with caution. Deviation from normal level may be due to the presence of other substances. Fire hazard potential. Discontinue investigation. Consult a fire safety specialist.
Radiation	Radiation survey equipment	≤2 mrem/hr[e,f] >2 mrem/hr	Radiation above background levels (normally 0.01-0.02 mrem/hr)[g] signifies the possible presence of radiation sources. Continue investigation with caution. Perform thorough monitoring. Consult with a health physicist. Potential radiation hazard. Evacuate site. Continue investigation only upon the advice of a health physicist.
Inorganic and organic gases and vapors	Colorimetric tubes Chemical-specific instruments, including halide meter, hydrogen sulfide detector, carbon monoxide monitor, and mercury meter	Depends on chemical	Consult standard reference manuals for air concentration/toxicity data. Action level depends on PEL/REL/TLV.[h]
Organic gases and vapors	Portable photoionizer Organic vapor analyzer (1) Operated in gas chromatography (GC) mode (2) Operated in survey mode	Depends on chemical	Consult standard reference manuals for air concentration/toxicity data. Action level depends on PEL/REL/TLV.[h]

[a]Based on *Standard Operating Guides*. U.S. EPA. December, 1984.
[b]These are general classes of hazards. Not all components of these classes can be measured.
[c]Consult manufacturers' literature for use limitations associated with the specific equipment and for the specific substances the equipment can detect. See Tables 7-1 and 7-2 for more complete descriptions.
[d]LEL = lower explosive limit.
[e]mrem/hr = milliroentgen equivalent in man per hour
[f]Source: U.S. Nuclear Regulatory Commission Rules and Regulations, 10 CFR Chapter 1, Part 20.105.
[g]Source: Sax, I.N. 1979. Dangerous Properties of Industrial Materials. Fifth Edition. p. 167. Van Nostrand Reinhold Company, New York.
[h] PEL = OSHA permissible exposure limit.
REL = NIOSH recommended exposure limit.
TLV = threshold limit value. See Table 6-4.

These documents should be controlled to ensure that they are all accounted for when the project is completed. The task of document control should be assigned to one individual on the project team and should include the following responsibilities:

- Numbering each document (including sample labels) with a unique number.
- Listing each document in a document inventory.

- Recording the whereabouts of each document in a separate document register so that any document can be readily located. In particular, the name and location of site personnel that have documents in their possession should be recorded.
- Collecting all documents at the end of each work period.
- Making sure that all document entries are made in waterproof ink.
- Filing all documents in a central file at the completion of the site response.

Field personnel should record all onsite activities and observations in a field logbook-a bound book with consecutively numbered pages. Entries should be made during or just after completing a task to ensure thoroughness and accuracy. Table 6-3 shows the level of detail that should be recorded during sampling.

Photographs can be an accurate, objective addition to a field worker's written observations. For each photograph taken, the following information should be recorded in the field logbook:

- Date, time, and name of site.
- Name of the photographer.
- Location of the subject within the site.
- General compass direction of the orientation of the photograph.
- General description of the subject.
- Sequential number of the photograph and the film roll number.
- Camera, lens, and film type used for photography.

Table 6-3. Example of Field Logbook Entries to Describe Sampling

• Date and time of entry.
• Purpose of sampling.
• Name, address, and affiliation of personnel performing sampling.
• Name and address of the material's producer, if known.
• Type of material, e.g., sludge or wastewater.
• Description of material container.
• Description of sample.
• Chemical components and concentrations, if known.
• Number and size of samples taken.
• Description and location of the sampling point.
• Date and time of sample collection.
• Difficulties experienced in obtaining sample (e.g., is it representative of the bulk material?).
• Visual references, such as maps or photographs of the sampling site.
• Field observations, such as weather conditions during sampling periods.
• Field measurements of the materials, e.g., explosiveness, flammability, or Ph.
• Whether chain-of-custody forms have been filled out for the samples.

Serially numbered sample labels or tags should be assigned to sampling team personnel and recorded in the field logbook. Lost, voided, or damaged labels should be noted in the logbook. Labels should be firmly affixed to the sample containers using either gummed labels or tags attached by string or wire. Information should be recorded on the tag in waterproof ink and should include items such as:

- The unique sample log number.
- Date and time that the sample was collected.
- Source of the sample, e.g., name, location, and type of sample.

- Preservative used.
- Analysis required.
- Name of collector.
- Pertinent field data.

In addition to supporting litigation, written records of sample collection, transfer, storage, analysis, and destruction help ensure the proper interpretation of analytical test results. Information describing the chain of custody should be recorded on a form that accompanies the sample from collection to destruction.

Hazard Assessment

Once the presence and concentrations of specific chemicals or classes of chemicals have been established, the hazards associated with these chemicals must be determined. This is done by referring to standard reference sources for data and guidelines on permissible levels of exposure, flammability, etc. Some key guidelines are listed in Table 6-4 and are described below.

Threshold Limit Value (TLV)®

TLVs can be used as a guideline for determining the appropriate level of worker protection. These values have been derived for many substances and can be found in *Threshold Limit Values for Chemical Substances and Physical Agents*, which is published annually by the American Conference of Governmental Industrial Hygienists (ACGIH) 121. The ACGIH defines three categories of TLVs: time-weighted average (TWA); short-term exposure limit (STEL); and ceiling (C).

All three categories may be useful in selecting levels of protection at a hazardous waste site. Refer to the *Threshold Limit Values for Chemical Substances and Physical Agents* [2] for additional details.

Permissible Exposure Limit (PEL)

Permissible exposure limits are enforceable standards promulgated by OSHA. In many cases they are derived from TLVs published in 1968. The PEL for a substance is the 8-hour time-weighted average or ceiling concentration above which workers may not be exposed. Although personal protective equipment may not be required for exposures below the PEL, its use may be advisable where there is a potential for overexposure. See the tables and substance-specific standards in 29 CFR Part 1910, Subpart Z, for additional details.

Recommended Exposure Limit (REL)

A NIOSH recommended exposure limit (REL) is the workplace exposure concentration recommended by NIOSH for promulgation by OSHA as a PEL, but is not enforceable as is the OSHA PEL. In some cases, NIOSH has described time-weighted average concentrations in terms of 10-hour, rather than 8-hour, averages.

Table 6-4. Guidelines for Assessing Chemical and Physical Hazards

HAZARD	GUIDELINE		EXPLANATION	SOURCES FOR VALUES[a]
Inhalation of airborne contaminants	TLV	Threshold Limit Value	One of three categories of chemical exposure levels, defined as follows:	
	TLV-TWA	Threshold Limit Value-Time-Weighted Average	The time-weighted average concentration for a normal 8-hour workday and a 40-hour work week, to which nearly all workers may be repeatedly exposed without adverse effect. Should be used as an exposure guide rather than an absolute threshold.	ACGIH
	TLV-STEL	Threshold Limit Value-Short-Term Exposure Limit	A 15-minute time-weighted average exposure that should not be exceeded at any time during the work day.	ACGIH
	TLV-C	Threshold Limit Value-Ceiling	The concentration that should not be exceeded even instantaneously.	ACGIH
	PEL	Permissible Exposure Limit	Time-weighted average and ceiling concentrations similar to (and in many cases derived from) the threshold limit values published in 1968.	OSHA
	REL	Recommended Exposure Limit	Time-weighted averages and ceiling concentrations based on NIOSH evaluations.	NIOSH
	IDLH	Immediately Dangerous to Life or Health	The maximum level from which a worker could escape without any escape-impairing symptoms or any irreversible health effects.	NIOSH
Dermal absorption of chemicals through airborne or direct contact Dermal irritation	Designation "skin"		The designation "skin" in the ACGIH, OSHA, and NIOSH references[a] indicates that a substance may be readily absorbed through the intact skin; however, it is not a threshold for safe exposure. Direct contact with a substance designated "skin" should be avoided. Many substances irritate skin. Consult standard references	ACGIH/ OSHA/ NIOSH
Carcinogens	TLV	Threshold Limit Value	Some carcinogens have an assigned TLV.	ACGIH
	PEL	Permissible Exposure Limit	OSHA has individual standards for some specific carcinogens.	OSHA
	REL	Recommended Exposure Limit	NIOSH makes recommendations regarding exposures to carcinogens.	NIOSH
Noise	TLV	Threshold Limit Value	Sound pressure levels and durations of exposure that represent conditions to which it is believed that nearly all workers may be repeatedly exposed without an adverse effect on their ability to hear and understand normal speech.	ACGIH
	PEL	Permissible Exposure Limit	.Limits for acceptable noise exposure.	OSHA
	REL	Recommended Exposure Limit	Limits for acceptable noise exposure.	NIOSH
Ionizing Radiation	Maximum permissible body burden and maximum permissible concentrations of radionuclides in air and in water.			NCRP

HAZARD	GUIDELINE		EXPLANATION	SOURCES FOR VALUES[a]
	PEL	Permissible Exposure Limit	Dose in rems per calendar quarter.	OSHA

[a]Sources:
ACGIH. 1984-85. Threshold Limit Values for Chemical Substances and Physical Agents in the Workplace Environment and Biological Exposure Indices with Intended Changes for 1985-86. American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio.
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NCRP. Basic Radiation Protection Criteria. NCRP Report No. 39. National Council on Radiation Protection and Measurements, Washington, D.C.
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NFPA. 1985. Fire Protection Guide on Hazardous Materials. Eighth Edition. National Fire Protection Association, Boston, Massachusetts.
OSHA. 29 CFR Part 1910. (OSHA standards are legally binding.)
[b]Other sources have slightly different definitions of IDLH (see IDLH Concentrations in this chapter).

IDLH Concentrations

IDLH exposure concentrations have been established by the NIOSH/OSHA Standards Completion Program (SCP) as a guideline for selecting respirators for some chemicals. The definition of IDLH varies depending on the source. For example, the Mine Safety and Health Administration Standard (30 CFR Part 11.3(t)) defines IDLH conditions as those that pose an immediate threat to life or health or that pose an immediate threat of severe exposure to contaminants such as radioactive materials that are likely to have adverse cumulative or delayed effects on health. The NIOSH *Pocket Guide to Chemical Hazards* [3] defines IDLH concentration as the "... maximum level from which one could escape within 30 minutes without any escape-impairing symptoms or any irreversible health effects....." The American National Standards Institute, Inc. (ANSI) defines IDLH as "....any atmosphere that poses an immediate hazard to life or produces immediate irreversible debilitating effects on health ..." [4]. Regardless of their exact definition, all IDLH values indicate those concentrations of toxic substances from which escape is possible without irreversible harm should a worker's respiratory protective equipment fail. At hazardous waste sites, IDLH concentrations should be assumed to represent concentrations above which only workers wearing respirators that provide the maximum protection (i.e., a positive-pressure, full-facepiece, self-contained breathing apparatus [SCBA] or a combination positive-pressure, full-facepiece, supplied-air respirator with positive-pressure SCBA [see Chapter 8) are permitted. Specific IDLH values for many substances can be found in the NIOSH *Pocket Guide to Chemical Hazards* [3].

Potential Skin Absorption and Irritation

Information on skin absorption is provided in the ACGIH publication, *Threshold Limit Values for Chemical Substances and Physical Agents* [2] and in OSHA standard 29 CFR Part 1910.1000 and other standard references. These documents identify substances that can be readily absorbed through the skin, mucous membranes, and/or eyes by either airborne exposure or direct contact with a liquid. This information, like most available information on skin absorption is qualitative. It indicates whether, but not to what extent, a substance may pose a dermal hazard. Thus decisions made concerning skin hazards are necessarily judgmental. In addition, many chemicals, although not absorbed through the skin, may cause skin irritation at the point of contact. Signs of skin irritation range from redness, swelling, or itching to burns that destroy skin tissue. Standard references can be used to determine whether a chemical may act as an irritant.

Potential Eye Irritation

Quantitative data on eye irritation are not always available. Where a review of the literature indicates that a substance causes eye irritation, but no threshold is specified, have a competent health professional evaluate the data to determine the level of personal protection needed for onsite workers.

Explosion and Flammability Ranges

The lower explosive limit (LEL) or lower flammable limit (LFL) of a substance is the minimum concentration of gas or vapor in air below which the substance will not burn when exposed to a source of ignition. This concentration is usually expressed in percent by volume. Below this concentration, the mixture is too "lean" to burn or explode.

The upper explosive limit (UEL) or upper flammable limit (UFL) of a substance is the maximum concentration of gas or vapor above which the substance will not burn when exposed to a source of ignition. Above this concentration, the mixture is too "rich" to burn or explode.

The flammable range is the range of concentrations between the LFL and UFL where the gas-air mixture will support combustion'.

The flashpoint of a substance is the minimum temperature at which it gives off sufficient vapor to form an ignitable mixture with the air just above the surface of the substance. Ignition of a substance at the flashpoint is not continuous.

The ignition temperature or autoignition temperature is the minimum temperature required to initiate or cause self-sustained combustion without an ignition source.

When evaluating the fire or explosion potential at a hazardous waste site, all equipment used should be intrinsically safe or explosion-proof. Where flammable or explosive atmospheres are detected, ventilation may dilute the mixture to below the LEL/LFL. However, ventilation is generally not recommended if concentrations exceed the UFL/UEL, since the mixture will pass through the flammable/explosive range as it is diluted. Note that combustible gas indicator readings may not be accurate when oxygen concentrations are less than 19.5 percent.

Hazardous Substance Information Form

Information on the chemical, physical, and toxicologic properties of each compound known or expected to occur on site should be recorded on a Hazardous Substance Information Form (see Appendix C). Response personnel will then have the necessary health and safety information in one place, and new personnel can be quickly briefed. As many reference sources as possible should be used to fill out the sheets because the information may vary from one source to another. Material Safety Date Sheets provided by chemical manufacturers are one source for this information.

Monitoring

Because site activities and weather conditions change, an ongoing air monitoring program should be implemented after characterization has determined that the site is safe for the commencement of operations.

The ongoing monitoring of atmospheric chemical hazards should be conducted using a combination of stationary sampling equipment, personnel monitoring devices, and periodic area monitoring with direct-reading instruments (see Chapter 7, *Air Monitoring*).

Data obtained during offsite and onsite surveys can be used to develop a plan that details the procedures to be used for monitoring ambient conditions during cleanup operations. Where necessary, routes of exposure other than inhalation should be monitored. For example, skin swipe tests may be used to determine the effectiveness of personal protective clothing (see Chapter 10, *Decontamination*). Depending on the physical properties and toxicity of the onsite materials, community exposures resulting from hazardous waste site operations may need to be assessed [5].

Monitoring also includes continual evaluation of any changes in site conditions or work activities that could affect worker safety. When a significant change occurs, the hazards should be reassessed. Some indicators of the need for reassessment are:

- Commencement of a new work phase, such as the start of drum sampling.
- Change in job tasks during a work phase.
- Change of season.
- Change in weather.
- Change in ambient levels of contaminants.

References

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